Citizen science in Denmark at a critical stage: a national survey across research fields, institutions, and projects

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Citizen science (CS) is an international field based on widely accepted—although often contested—principles, typologies, and definitions. In comparison, national and local differences get relatively little attention. Our paper offers insights into the CS field in Denmark. We report on results from our 2020 study of CS activities in Denmark. The study included a literature review, a questionnaire distributed by email to members of known CS projects and allowing for access by means of self-enrolment (N=187), and a desk study of projects and actors with relation to the concept of CS. We found an increase in the number of CS-related publications from Danish universities from 2014 onwards. Nearly all publications were research publication, and very few directed towards larger audiences. We also found that the Danish CS field included all fields of scientific inquiry, including the social sciences and humanities. Most projects (65 %) dealt with nature—biology and ecology—as an object of study. Nearly all projects used CS as a research method, and very few as a mode of public engagement or activism. Our survey respondents represented different CS stakeholders: universities, research libraries, museums, public institutions (agencies, public libraries, etc.), NGOs, companies, and private citizens. They were generally interested in and knowledgeable about CS. Collectively, they identified the following problems for CS in Denmark: volunteer retention and recruitment, institutional backing, public awareness, ethical approval of projects, acceptance of CS as a research method, and human resources for doing CS. In conclusion, CS is an emerging field at a critical stage. It has attracted interest yet still faces challenges, such as increasing and maintaining institutional support, consolidating existing organizational structures, creating incentives for researchers and citizens, information and advocacy, capacity-building, and attention to ethical and legal issues.

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1. Introduction

Citizen science (CS), like science, is widely understood as an international idea or movement [1-3]. Few studies undertake analysis of national contexts of CS [4-7]. Denmark has strong cultural roots in participatory governance of science and technology: public participation in scientific research, citizen-led decision-making, and institutionalized "consensusing" [8, 9]. However, a more recent shift towards more one-way dissemination of science to increase public understanding (and appreciation) of science and top-down decision-making in science administration has been observed [10]. A 2018 evaluation of CS in Denmark concluded that Danish CS projects understood CS mostly as top-down facilitated, instrumentalized public participation in scientific data-collection [11]. In 2020 we performed a survey of CS projects, actors, and publications to enrich our understanding of CS in Denmark. The full results are available in our open-access report (in Danish) [12]. Here we report some of the most important results and discuss their implications for CS in the Danish context.

2. Methods and materials

2.1 Identifying active projects

We used lists of projects from the Danish CS portal and the 2018 survey mentioned above [11, 13]. We consulted web portals of BirdLife Denmark (Dansk Ornitologisk Forening), the National Museum of Natural History (Statens Naturhistoriske Museum) and the University of Southern Denmark's CS Knowledge Hub. We also performed our own searches on the Internet using "citizen science" (and equivalent Danish terms: "borgervidenskab", "borgerforskning", "medborgerforskning"). We collected information about disciplinary affiliation of projects and institutions involved in projects. We updated all available information to see if the projects were still active at the time of data collection.

2.2 Surveying CS project managers, researchers, and research librarians

For our survey we recruited active CS project managers and workers, CS researchers, master's students taking a CS course held at Aarhus University in autumn 2019, and research librarians (because the survey also addressed issues about CS and research libraries). We identified potential survey participants by means of publicly available information about participants at the first CS Symposium in Denmark, October 7, 2019, held at the University of Southern Denmark, and information about project members publicly available on active project portals. We used the mailing list Forsk-bib-l to reach research librarians. A total of 205 respondents was identified this way.

We allowed survey participants to distribute a self-enrolment link to other active CS researchers or project managers. We shared information about the survey on social media (Twitter, LinkedIn and Facebook).

We designed the survey questions based on information about other surveys [11, 14-15]. The questionnaire had four parts: 1) Background (three questions about age, gender, and educational attainment), 2) Knowledge about and interest in CS (four questions) and experiences (if any) from previous projects (four questions asked only if the respondent was active in CS), 3) Opportunities and Challenges for CS (nineteen questions split in three groups—these questions were only posed

to participants with some knowledge about CS or active involvement in CS projects), 4) Opportunities and Challenges for CS in research libraries (ten questions and one hierarchical question). We performed a pilot test with members of our advisory panel (see acknowledgments) and revised the questionnaire accordingly. Our survey was not specifically aimed at CS volunteers.

We implemented our survey on SurveyXact, a tool designed by the international consultant firm Rambøll and used under our university's license for the current study. We informed all participants about the survey and its purpose, and we asked for their permission to collect and store data. The survey was anonymous, so we informed all participants that they were unable to withdraw their participation after submitting their answers, i.e., after anonymization.

2.3 Mapping publications

We used the Research Portal Denmark, which collects bibliometric information about research publications from Danish research institutions. We performed three iterative searches. First, we searched the database for publications using "citizen science" as our basic search string. We then looked at all abstracts from the articles obtained to identify new CS-relevant search terms: semantic derivations of "citizen science" such as "citizen-science" or "citizen scientists", Danish translations such as "borgervidenskab", and terms that capture involvement of members of the public in scientific research such as "public participation in science" or "community engagement for science". The additional search terms were all derived from abstracts of articles identified in our searches and all were approved by two of the authors (KHN and TEA) before they were used in new searches.

3. CS in Denmark

3.1 CS projects

We identified a total of 64 projects, most of which were active by the end of 2020. We categorized the projects according to their main disciplinary affiliation, see figure 1.
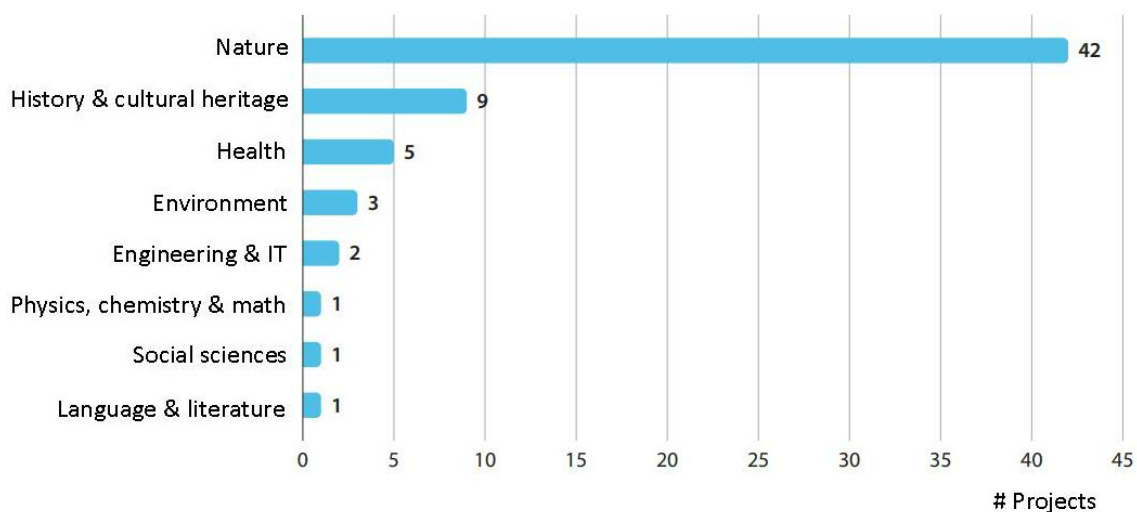

Figure 1: Number of CS projects (N=64) for each disciplinary category.

Two thirds of all projects are found in the nature category. These are projects related to species observations or monitoring and nature management. The longest CS-nature project is the bird ringing scheme going back to 1899. Today, it is administered by the National Museum of Natural History (Staten Naturhistoriske Museum) and the Environmental Protection Agency (Miljøstyrelsen). The largest CS-nature project was probably BiodiversityNow (BiodiversitetNu), which involved more than 27.000 participants doing more than 1.1 million observations.

The second largest group of CS projects involves history and cultural heritage. Most of the projects in this category were run by the National Archive (Rigsarkivet). They involve volunteers (amateur historians) who assist archivist in transcribing and digitizing historical records. In the history and cultural heritage category, we also find one of the world's largest projects for amateur archeologists, Digital Metal Detector Finds (Digitale Metaldetektorfund), run by archeologists at Aarhus University and Association of Danish Amateur Archaeologists. More than 2600 amateur archeologists use the database, which has more than 100,000 finds registered.

We also identified the institutions involved in each CS project, see figure 2.
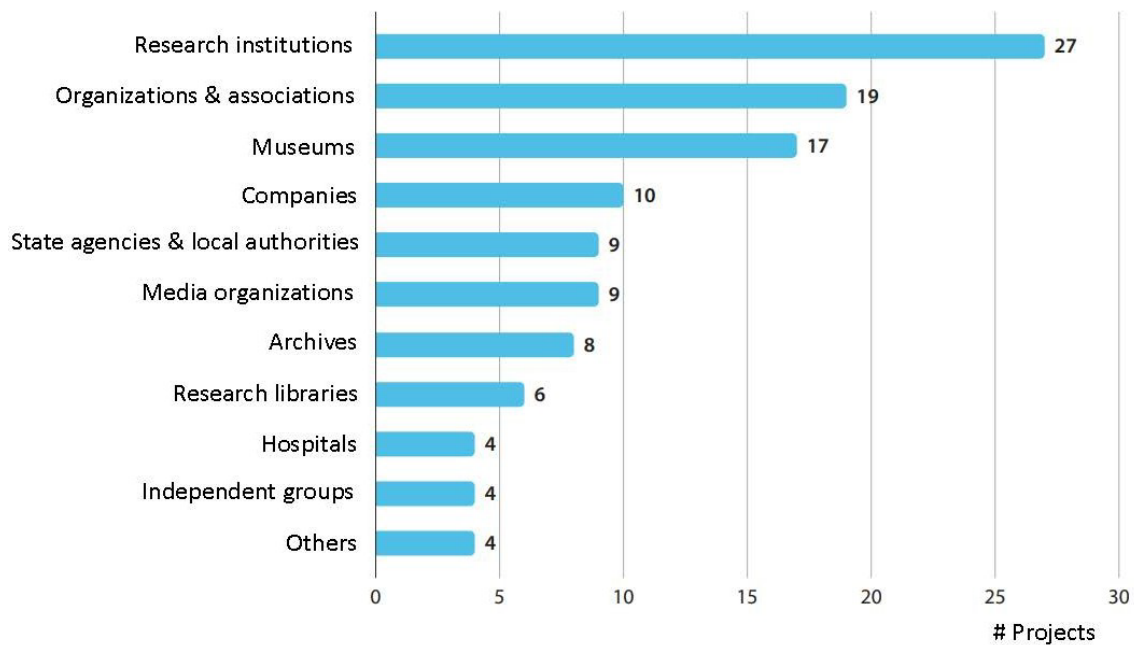

Figure 2: Institutions involved in CS projects (more than one institution allowed for each project).

We noted the diversity of institutions involved in CS projects, including NGOs, public authorities, and media organizations.

3.2 CS actors

We distributed the survey to 205 individuals, receiving 114 full replies (response rate = 55.6 %). An additional 73 individuals self-enrolled to take the survey. A total of 161 respondents completed the survey (completion rate = 86.0 %). Demographic information is presented in table 1. In the following, we only provide some results about respondents' familiarity with and attitudes to CS. Full results are available in our open-access report [12].

Table 1: Demographic information about respondents

Demographic variable	Key information about respondents
Gender (N=187)	Women: 58 % (n=109)
	Men: 40 % (n=75)
	Declined: 2 % (n=3)
Age (N=187)	19-25 y: 3 % (n=5)
	26-35 y: 17 % (n=31)
	36-45 y: 25 % (n=47)
	46-55 y: 32 % (n=60)
	56-65 y: 20 % (n=37)
	66-75 y: 3 % (n=5)
	Declined: 1 % (n=2)
Eduational attainment (N=187)	PhD: 26 % (n=49)
	Tertiary: 68 % (n=126)
	Secondary: 3 % (n=5)
	Primary: 1 % (n=1)
	Other: 2 % (n=3)
	Declined: 2 % (n=3)

3.2.1 CS familiarity and interest

We asked respondents to estimate their own familiarity with CS and their interest in being engaged in CS projects going forward, professionally, or as a volunteer, see figures 3-5.

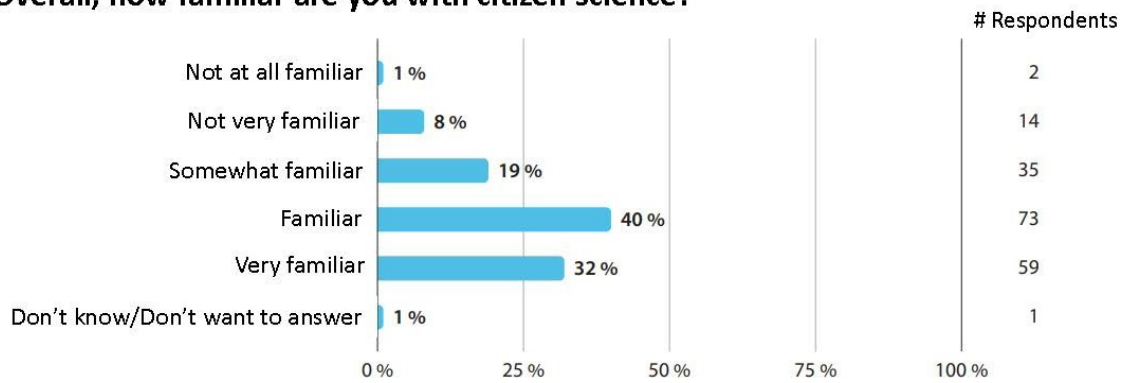**Overall, how familiar are you with citizen science?**

	# Respondents
Not at all familiar	1 % — 2
Not very familiar	8 % — 14
Somewhat familiar	19 % — 35
Familiar	40 % — 73
Very familiar	32 % — 59
Don't know/Don't want to answer	1 % — 1

Figure 3: CS familiarity (N=184).

Overall, how interested are you in getting professionally involved in citizen science?
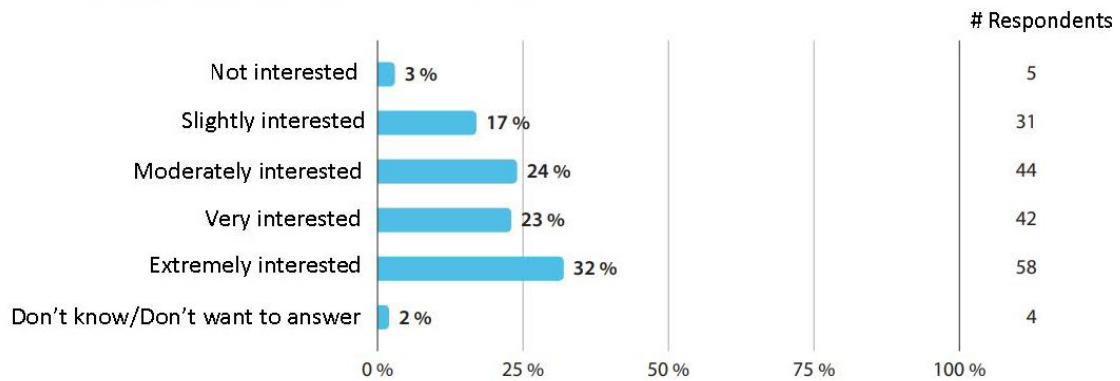

Figure 4: Interest in professional engagement in CS (N=184).

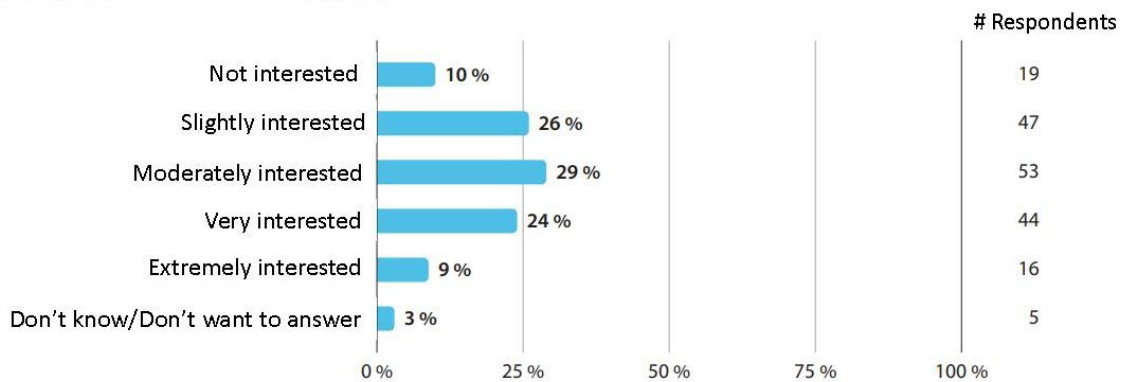**Overall, how interested are you in getting involved in citizen science as a volunteer?**

Figure 5: Interest in volunteer engagement in CS (N=184).

Obviously, our respondents are mostly familiar with CS. Most of the respondents report an interest in getting (or staying) actively involved in CS projects in the future. Most respondents report an interest in working with CS on a professional basis.

3.2.2 Attitudes to CS

We asked about attitudes to CS in terms of what CS can accomplish, what best describes CS, and what CS should achieve, see figures 6-8.

How easy/difficult is it for CS projects to accomplish the following goals?
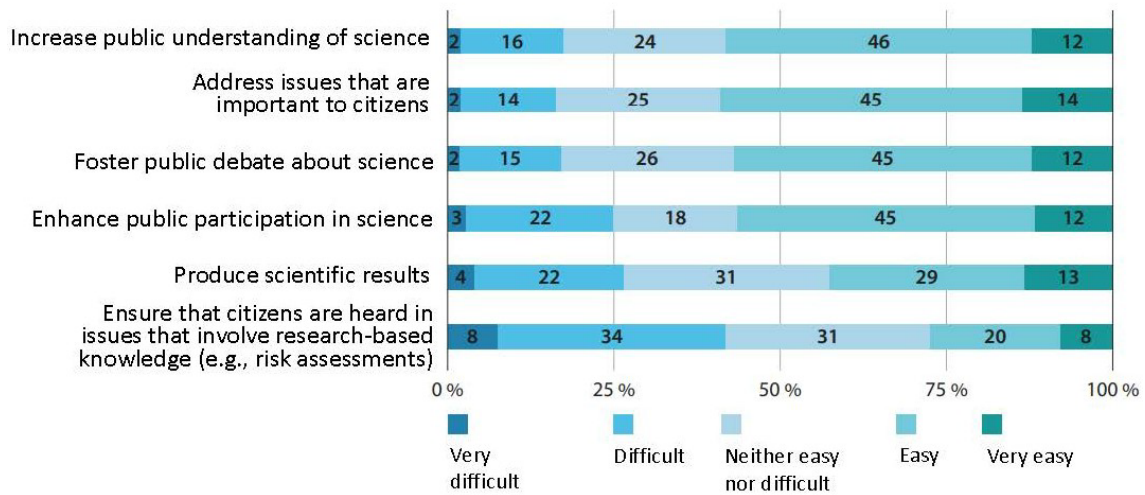

Figure 6: Attitudes to CS (what CS accomplishes).

Our respondents seem to think that it more easy than difficult to accomplish the first four goals of CS. For the last two goals, they are more divided. We were a bit surprised to find that less than 50 % of our respondents agreed that "Produce scientific results" is easy or very easy. It may be that they have come to realize that CS requires more work than ordinary research projects for researchers and everyone involved.

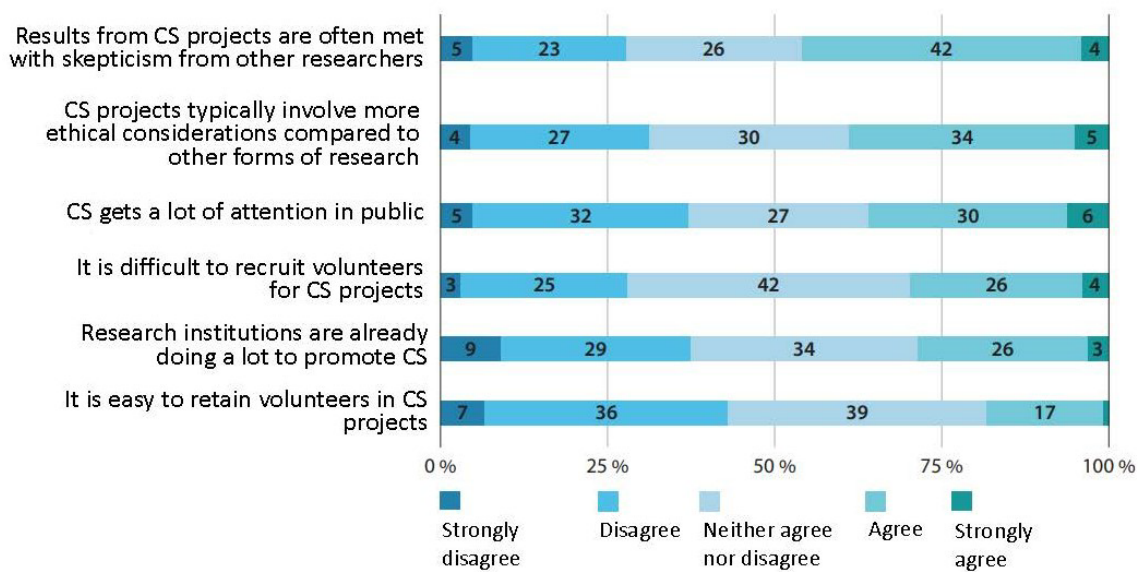**Do you agree or disagree with the following statements about citizen science (CS)?**

Figure 7: Attitudes to CS (what CS is or entails).

Our respondents tend to agree with the statement that CS projects are met with skepticism from other researchers (although agreement is less than 50 %). They also tend to disagree with the statement that it is easy to retain volunteers if CS projects (again, disagreement is less than 50 %). For the rest of the statements, their opinions are more divided.

Do you agree or disagree with the following statements about citizen science (CS)?
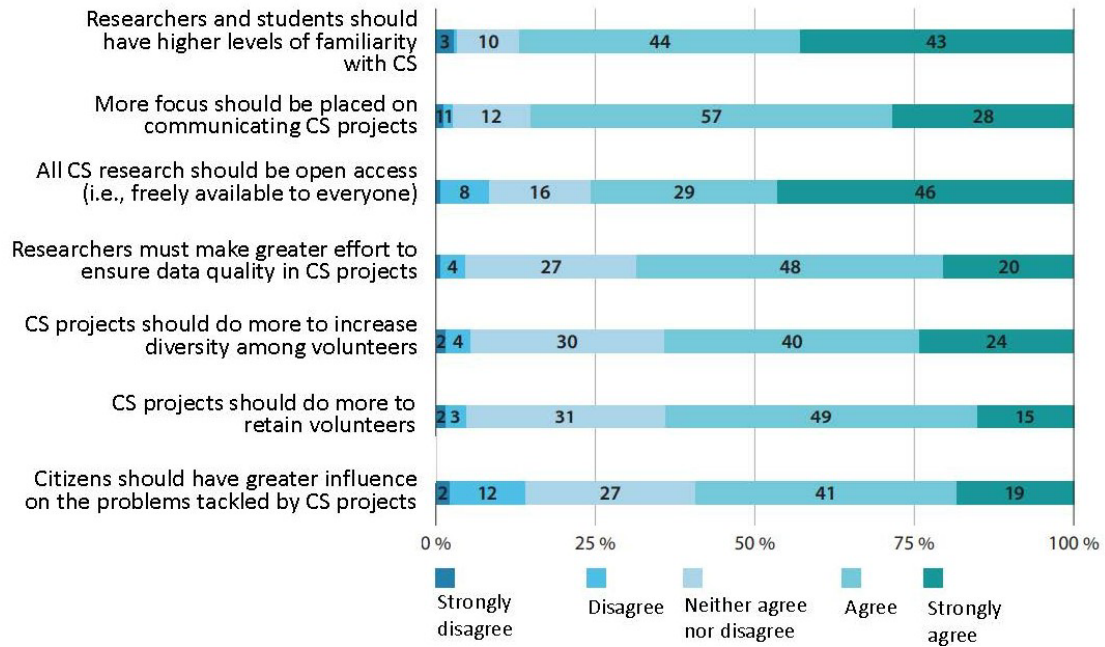

Figure 8: Attitudes to CS (what CS should be).

Our respondents tend to agree on all statements about what CS should be (level of agreement is higher than 50 %). They agree least on the last statement about co-created CS projects.

3.3 Publications

We identified 156 CS-related publications. We used bibliometric information from Research Portal Denmark to classify these publications according to year, publication type, language, and disciplinary and institutional affiliation, see figures 9-13.
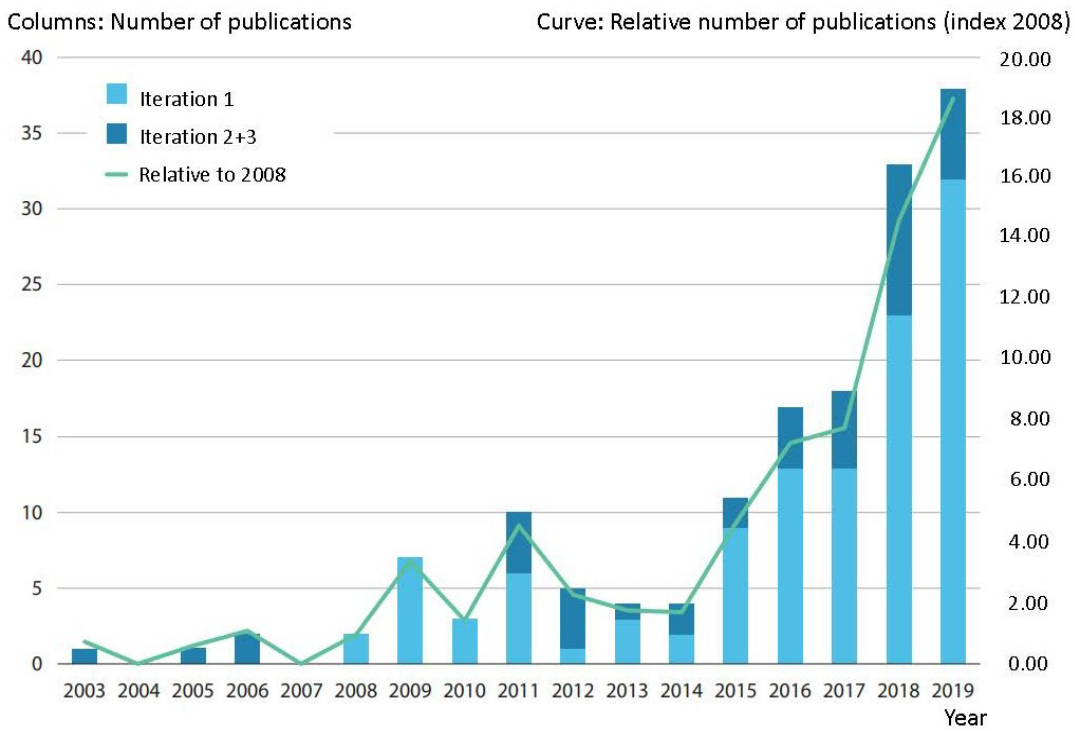
Figure 9: Number of CS-related publications per year in absolute (columns) and relative (curve) numbers.

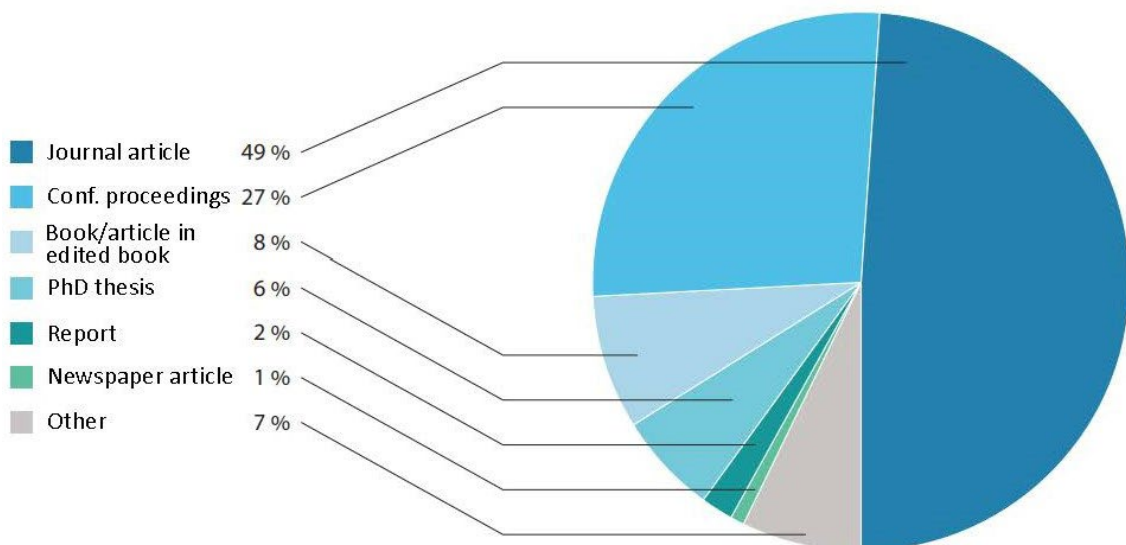The number of CS-related publications has increased steadily in the last decade or so.

Figure 10: CS-related publication types.

Most CS-related publications are journal articles. The Research Portal Denmark collects information about academic output and generally has relatively few newspaper articles or other publications aimed at non-academic audiences.
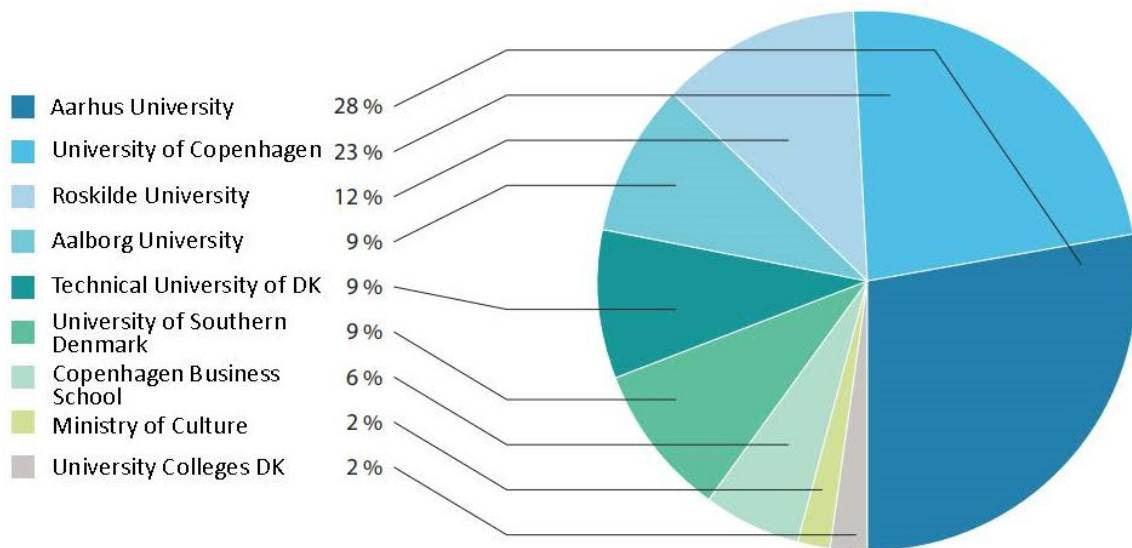
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Figure 11: Institutional affiliation of authors of CS-related publications.

Most authors come from the two biggest universities in Denmark, Aarhus University and University of Copenhagen. All Danish universities, except the IT University of Copenhagen, established in 1999, are active in publishing CS-related research.
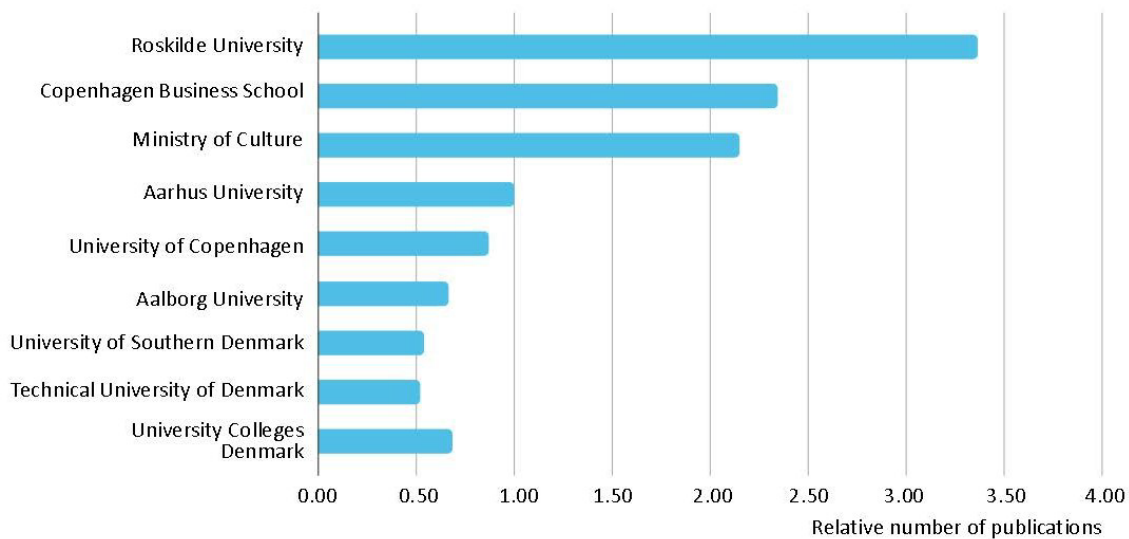

Figure 12: CS-related publications per institution relative to annual output registered by the Research Portal Denmark (Aarhus University as index 1.00).

In terms of relative numbers, i.e., the total number of CS-related publications divided by the total numbers of publications per institution, the two smaller Danish universities, Roskilde University and Copenhagen Business School, are most active. Both universities ran CS projects in the 2000s and early 2010s, namely the Citizen Science for Sustainability (SuScit) in 2006-2009 at Roskilde University and the Impact of Citizen Participation on Decision Making in a

Knowledge Intensive Policy Field in 2009-2012, both of which resulted in several articles and other publications.
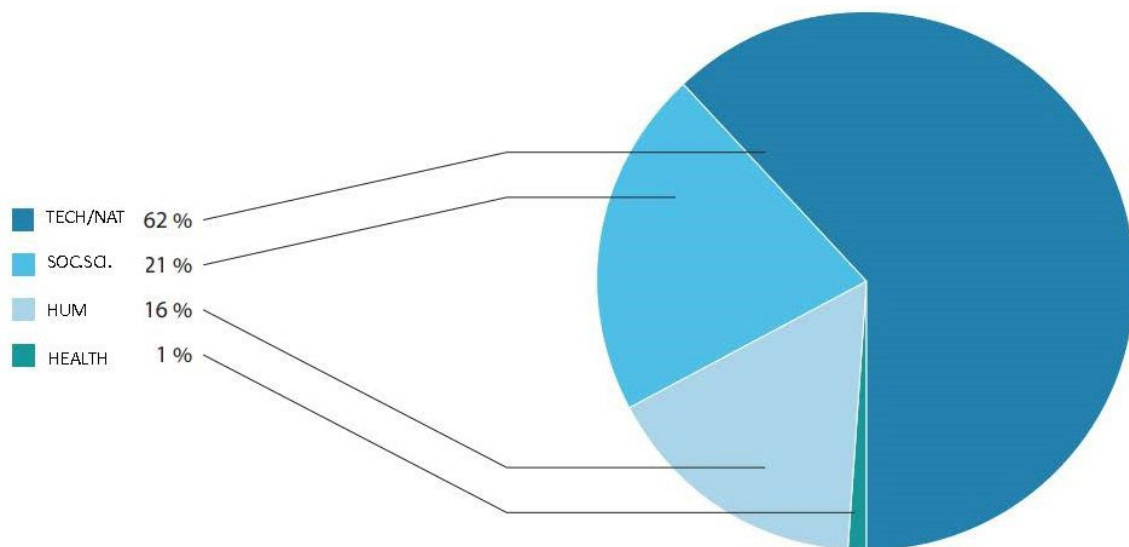

Figure 13: Disciplinary affiliations of CS-related publications (the affiliations are the ones used in the database).

Most publications are based in the technical and natural sciences. This is not surprising given the fact that most Danish CS projects revolve around research topics related to nature (see figure 1). However, the social sciences and humanities are also well represented with a total of 37 % of all publications. These publications typically revolve around issues such as citizen involvement in policymaking, action research, and technology assessment. We attribute the lack of health-related publications to the fact that health scientists use other terms when they report on research that actively involve patients. We found more than 600 publications in the database using the search terms "patient involvement" and "patient participation". These publications were not included in our results as the two search terms did not result from our iterative method (see method section above). Health research seems to be disconnected from CS in the Danish case.

4. Conclusion

CS is an emerging field in Denmark with many ongoing projects and an increasing number of research publications. Most Danish CS projects are nature-based, i.e., deal with research questions about wildlife, biodiversity, or ecology. We found a diversity of institutional actors involved in CS projects from research institutions and NGOs to public authorities, libraries, and independent groups. Our survey respondents, who are generally quite familiar with CS and represent many stakeholders actively involved in CS, agreed that CS is a useful tool to: 1) increase public understanding of science, 2) address issues that are important to citizens, 3) foster public debate about science, and 4) enhance public participation in science. What CS in Denmark accomplishes, to paraphrase Bruce Lewenstein from a paper prepared many years ago, is to embed scientific research more firmly in its wider social context [16].

Our respondents also agreed with statements suggesting that CS in Denmark faces challenges in terms of lacking recognition from scientific peers, ethical considerations,

institutional support, and volunteer recruitment and retention. Our survey respondents see opportunities for CS to contribute to science and society, yet they also seem to be wary that to succeed in the future CS needs to become more firmly embedded in existing organizational structures with incentives for researchers and citizens, information and advocacy, capacity-building, and attention to ethical and legal issues. In addition, more dedicated efforts are needed to communicate CS to researchers, students, and wider audiences, but also to ensure data quality, increase volunteer diversity and retain volunteers, and to allow for greater volunteer (citizen) influence on CS projects.

Potential drivers for CS include bottom-up activities such as networking, training, knowledge exchange, and outreach as well as top-down initiatives, for example institutional hubs and dedicated CS funding schemes [4]. Connecting CS to sustainability goals also seems like a way forward to promote CS more broadly [6-7]. In Denmark, there is a thriving community of CS practitioners, many CS projects with (potential) sustainability impact, and a continual stream of publications flowing from CS projects. Still lacking is the institutional recognition of CS from funders, managers, and policymakers, which probably remains the most significant impediment to CS in Denmark. In other words, Danish CS has reached a critical stage. CS clearly has demonstrated its potential; now the time has come for CS to become more institutionalized as a scientific practice and a form of participatory governance of science and technology.

Acknowledgments

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